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(54) **ANTENNA MODULE AND WIRELESS COMMUNICATION DEVICE EMPLOYING SAME**

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(51) **Int. Cl.**

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H01Q 5/00	(2015.01)
H01Q 1/24	(2006.01)
H01Q 9/42	(2006.01)
H01Q 5/378	(2015.01)

(52) **U.S. Cl.**

CPC ***H01Q 5/0055*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 5/378*** (2015.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**

USPC ..... 343/700 MS, 702

See application file for complete search history.

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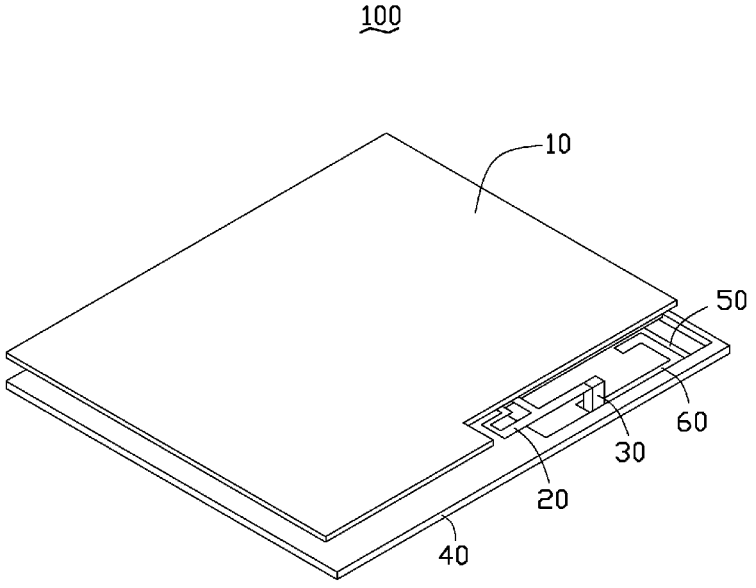
(57) **ABSTRACT**

An antenna module includes an antenna, a connecting member attached to the antenna, a sliding board configured for sliding relative to connecting member, and a radiation member attached to the sliding board. When the sliding board is slid by a user, the radiation member makes contact with or separates from the connecting member, enabling one antenna module to receive and transmit wireless signals of different wavelengths.

15 Claims, 4 Drawing Sheets



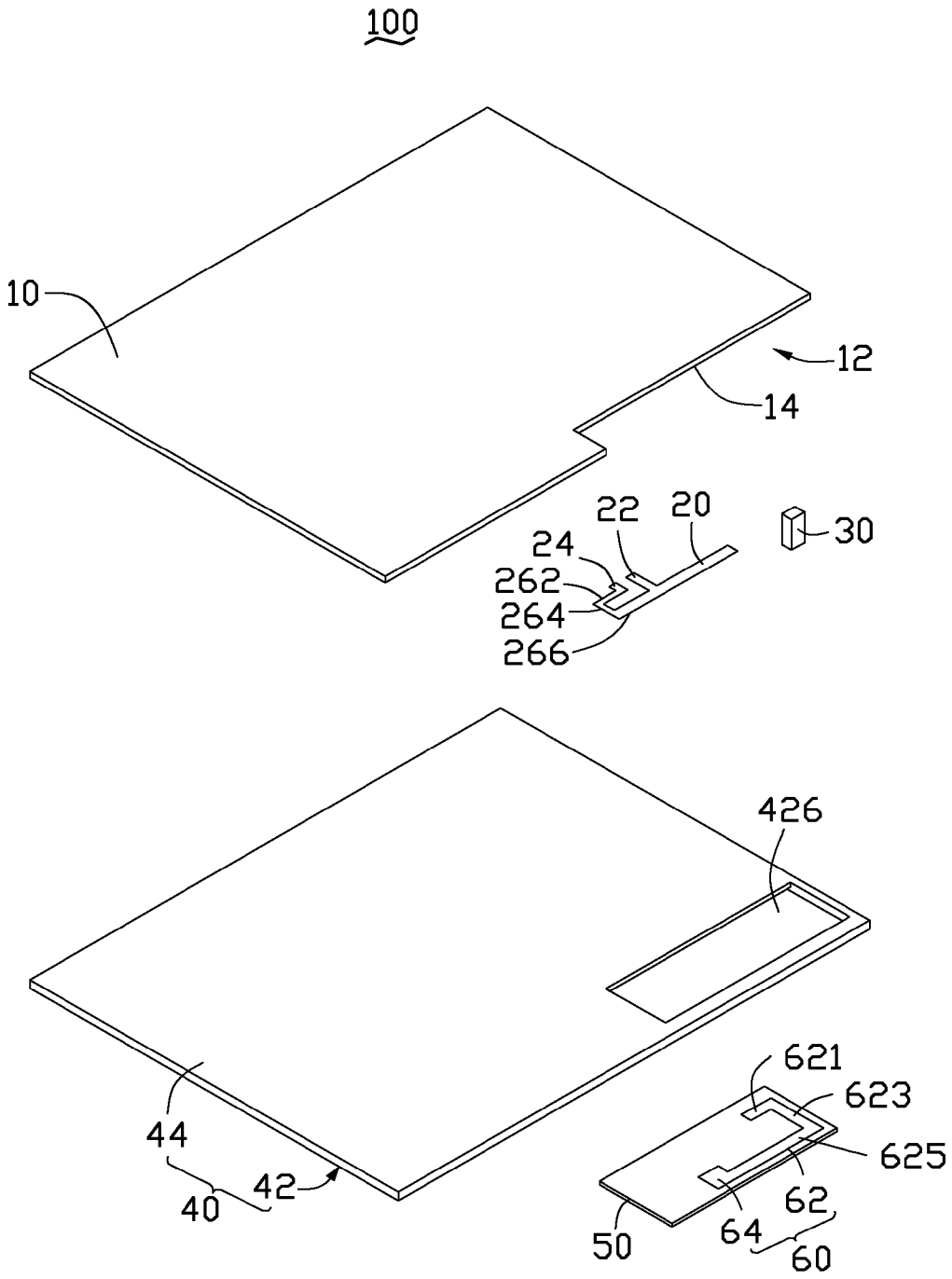

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FIG. 1

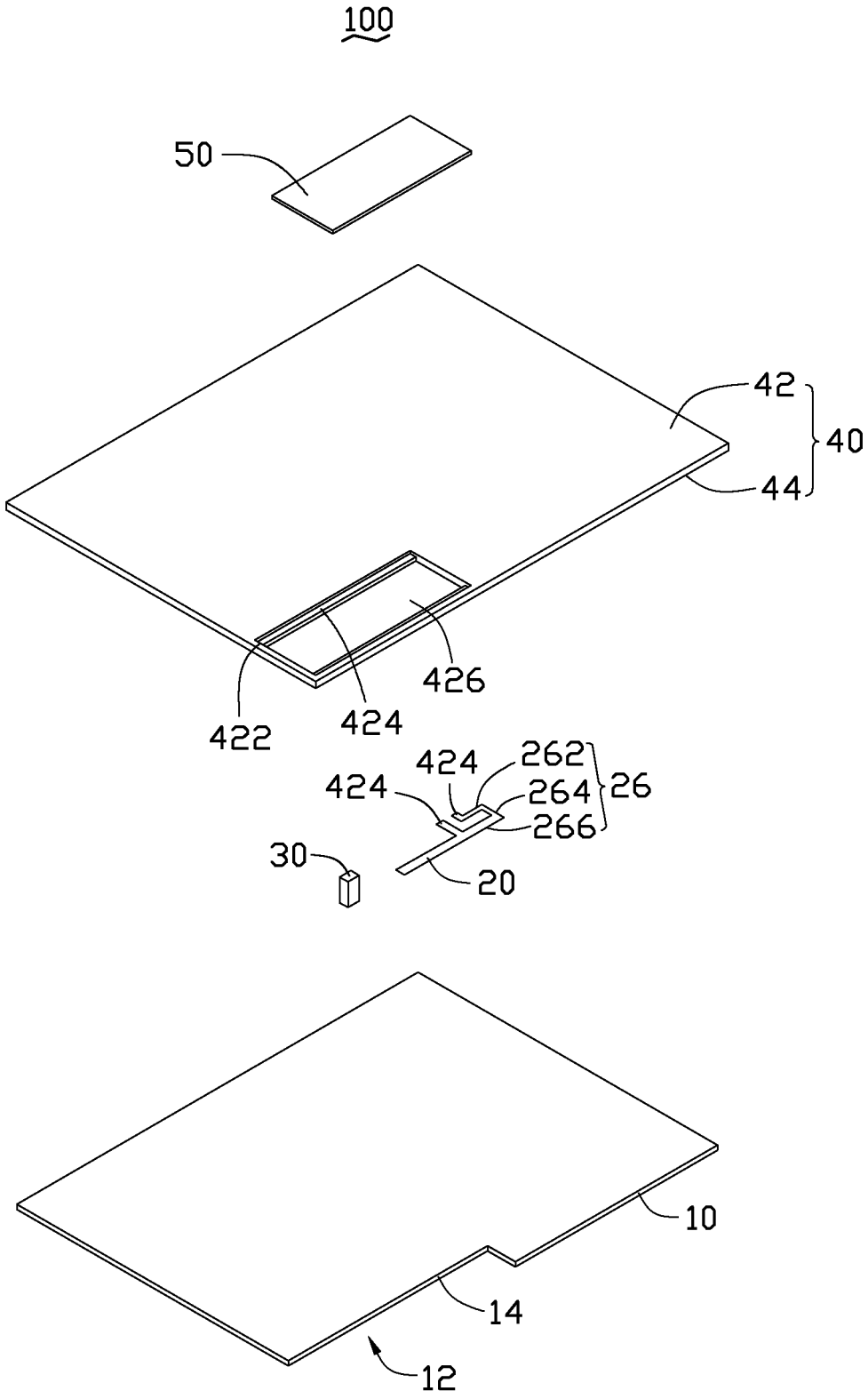

FIG. 2

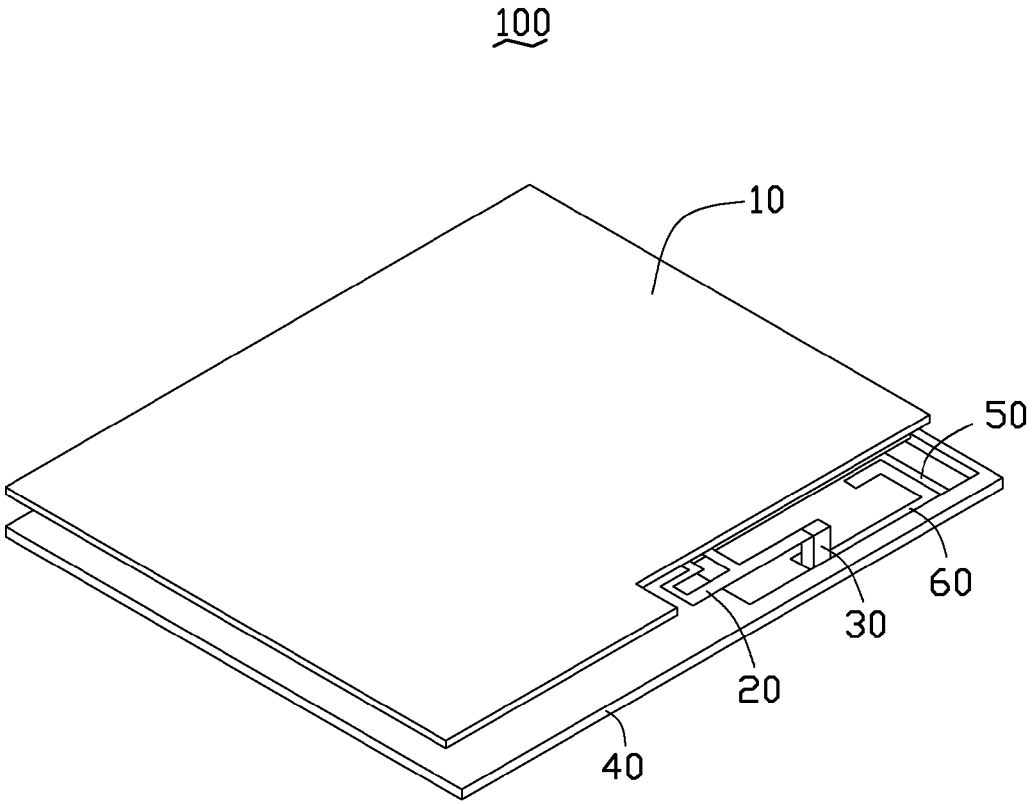

FIG. 3

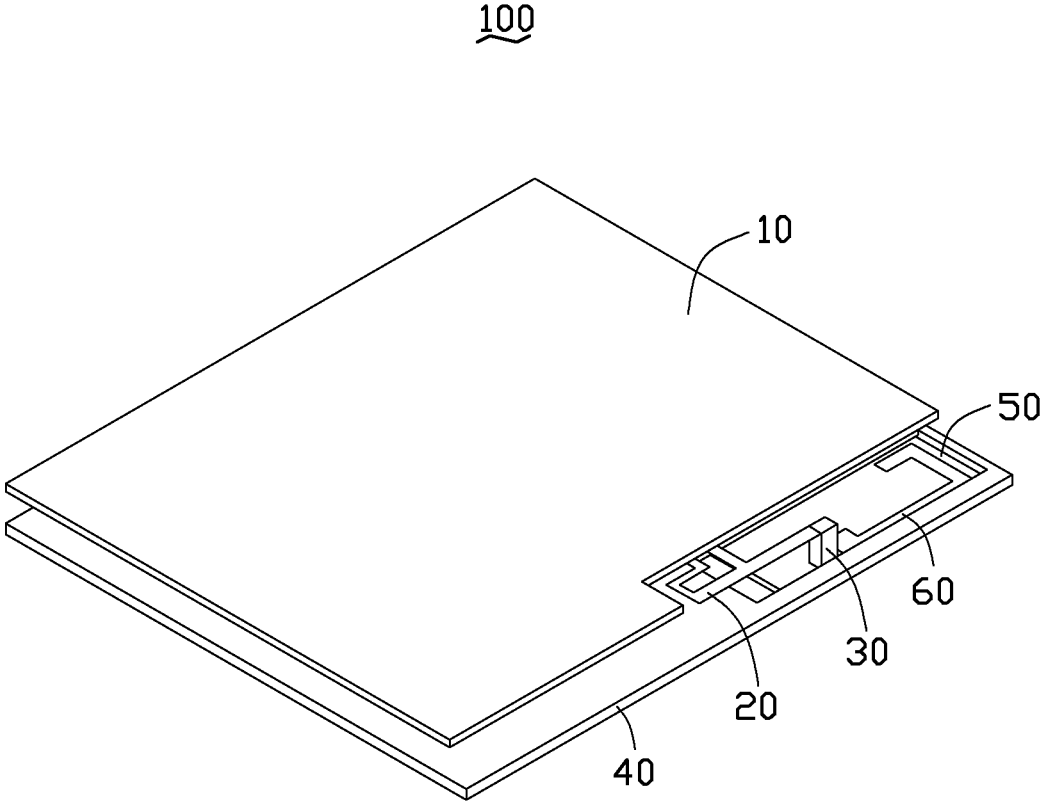

FIG. 4

ANTENNA MODULE AND WIRELESS COMMUNICATION DEVICE EMPLOYING SAME

BACKGROUND

1. Technical Field

The present disclosure relates to antenna modules and wireless communication devices employing the antenna modules.

2. Description of Related Art

Many wireless communication devices (such as mobile phones) have multiple frequency bands. Thus, multiple antennas are secured inside the devices, such as a GSM/CDMA wireless communication antenna, a WIFI antenna, and a GPS antenna. These antennas are located at different positions inside the devices to prevent mutual interference. However, multiple antennas require an increased manufacturing cost. Moreover, multiple antennas occupy more space, making it difficult to miniaturize the wireless communication devices.

Therefore, there is room for improvement within the art.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the disclosure can be better understood with reference to the drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the views.

FIG. **1** is an exploded view of an antenna module in accordance with an exemplary embodiment.

FIG. **2** is an exploded view of the antenna module of FIG. **1** viewed from another angle.

FIG. **3** is an assembled, isometric view of the antenna module of FIG. **1** in a first state.

FIG. **4** is an assembled, isometric view of the antenna module of FIG. **1** in a second state.

DETAILED DESCRIPTION

FIGS. **1** and **2** show an exemplary embodiment of a wireless communication device **100** incorporating an antenna module (not labeled). The wireless communication device **100** comprises a circuit board **10**, a cover board **40**, and the antenna module.

The circuit board **10** defines a notch **12** at one edge. The notch **12** has a sidewall **14** having an electrical feed point (not shown) and a grounding point (not shown) formed thereon. The feed point is configured for feeding current into the antenna module and the grounding point is configured for grounding the antenna module, enabling the antenna module to form a current loop.

The cover board **40** may be a portion of a housing of the wireless communication device **100**. The cover board **40** is positioned opposite to the circuit board **10**. The cover board **40** includes an outer surface **42** and an inner surface **44** opposite to the outer surface **42** and facing the circuit board **10**. The outer surface **42** defines a recess **422** which includes a bottom wall **424**. The bottom wall **424** defines an opening **426** through the inner surface **44**.

The antenna module comprises an antenna **20**, a connecting member **30**, a sliding board **50**, and a radiation member **60**.

The antenna **20** is made of conductive materials, such as metal. In the exemplary embodiment, the antenna **20** is a planar sheet parallel to the circuit board **10** and positioned in the notch **12** of the circuit board **10**, to save space. The antenna **20** includes a feeding end **22**, a grounding end **24**, and a radiation portion **26**. The feeding end **22**, the grounding end **24**, and the radiation portion **26** are all coplanar. The feeding end **22** is electronically connected to the feed point of the circuit board **10**, for feeding current into the antenna module. The grounding end **24** is electronically connected to the grounding point of the circuit board **10**, for grounding the antenna module. The radiation portion **26** has a first section **262**, a connecting section **264**, and a second section **266**. The first section **262** connects to the grounding end **24**. The connecting section **264** extends perpendicularly from the first section **262**. The second section **266** extends perpendicularly from the connecting section **264** and is located on a same side of the connecting section **264** as the first section **262**. The feeding end **22** connects to a substantially middle portion of the second section **266** and is substantially parallel to the connecting section **264**.

The connecting member **30** is made of conductive materials, such as metal. The connecting member **30** detachably and electronically connects the antenna **20** and the radiation member **60**. In the exemplary embodiment, the connecting member **30** is a flexible sheet which perpendicularly connects to an end of the second section **266** furthest from the connecting section **264** and extends towards the cover board **40**. Length of the connecting member **30** is substantially equal to distance between the circuit board **10** and the cover board **40**.

The sliding board **50** is made of plastic or some other non-conductive material. The sliding board **50** is slidably received in the recess **422** of the cover board **40** and opposite to the antenna **20**. In the exemplary embodiment, length of the sliding board **50** is smaller than length of the recess **422**, enabling the sliding board **50** to be pushed in one direction or another in the recess **422**. To ensure the sliding board **50** does not come out of the recess **422**, the sliding board **50** may further engage with other body portions of the wireless communication device incorporating the antenna module **100**.

The radiation member **60** is made of conductive materials, such as metal. The radiation member **60** is attached to a surface of sliding board **50** facing the circuit board **10** and is exposed from the opening **426**. The radiation member **60** may be formed by plating copper coating on the sliding board **50**, or by attaching metal sheet to the sliding board **50**. The radiation member **60** can also be formed by attaching flexible circuit board on the sliding board **50**.

In the exemplary embodiment, the radiation member **60** includes a main radiation section **62** and a contacting section **64**. The main radiation section **62** includes a first portion **621**, a second portion **623**, and a third portion **625**. The first and third portions **621**, **625** perpendicularly extend from the ends of the second portion **623**, and are located on the same side of the second portion **623**. Length of the third portion **625** is greater than length of the first portion **621**. The contacting section **64** perpendicularly extends from an end of the third portion **625** away from the second portion **623**. The contacting section **64** is substantially parallel to the second portion **623**. When the sliding board **50** slides in the recess **422**, the contacting section **64** makes contact with or separates from the connecting member **30**. When the contacting section **64** is in contact with the connecting member **30**, length of the current path formed in the antenna **20**, the connecting member **30**, and the radiation member **60** is in a certain proportion to the wavelength of GPS signals. Thus, the antenna **20**, the connecting member **30**, and the radiation member **60** cooperatively receive and transmit GPS signals. To ensure a good contact between the connecting member **30** and the contact-

ing section **64**, the contacting section **64** may be gold-plated. When the contacting section **64** separates from the connecting member **30**, length of the current path formed in the antenna **20** and the connecting member **30** is in a certain proportion to the wavelength of Bluetooth (BT) signals. Thus, the antenna **20** and the connecting member **30** cooperatively receive and transmit BT signals.

The operating principle of the antenna module **100** is as follows.

Referring to FIG. **4**, when the antenna module **100** is required to receive and transmit BT signals, the sliding board **50** slides to separate the contacting section **64** from the connecting member **30**. At this time, the antenna **20** and the connecting member **30** cooperatively form a BT antenna for receiving and transmitting BT signals. When the antenna module **100** is required to receive and transmit GPS signals, the sliding board **50** can be slid to bring the contacting section **64** into contact with the connecting member **30**, as shown in FIG. **3**. At this time, the antenna **20**, the connecting member **30**, and the radiation member **60** cooperatively form a GPS antenna for receiving and transmitting GPS signals.

The BT antenna and the GPS antenna share the same feeding end **22** and the same grounding end **24**, without defining independent and separate feeding ends and grounding ends for each of the BT antenna and the GPS antenna, thus effectively decreasing the space required for the antenna module **100** inside the wireless communication device.

It should be understood, that the antenna module **100** is not limited to receiving and transmitting BT and GPS signals. The antenna module **100** can also receive and transmit other signals, such as WIFI signals, by changing the effective size of the antenna **20** and the radiation member **60**. In addition, the antenna **20** and the radiation member **60** are not limited to the structures as set forth in the foregoing description, so long as the one or more lengths of current path formed therein is in a certain proportion to the wavelength of a desired wireless signal.

In addition, the antenna module **100** is not limited to receiving and transmitting only two kinds of signals. The antenna module **100** can also be used to receive and transmit more than two different kinds of signals by increasing the number of radiation members corresponding to wireless signals to be received to the sliding board **50**.

It is to be understood, however, that even through numerous characteristics and advantages of the present disclosure have been set forth in the foregoing description, together with details of assembly and function, the disclosure is illustrative only, and changes may be made in detail, especially in the matters of shape, size, and arrangement of parts within the principles of the disclosure to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. An antenna module, comprising:
an antenna;
a connecting member attached to the antenna;
a sliding board configured for sliding relative to connecting member; and
a radiation member attached to the sliding board;
wherein when the sliding board slides relative to the connecting member, the radiation member is in contact with or separates from the connecting member; and
wherein when the radiation member contacts the connecting member, the antenna, the connecting member, and the radiation member cooperatively receive and transmit a first signal; when the radiation member separates from the connecting member, only the antenna and the connecting member cooperatively receive and transmit a second signal.

2. The antenna module as claimed in claim **1**, wherein the antenna comprises a feeding end, a grounding end, and a radiation portion; the radiation portion has a first section, a connecting section, and a second section; the first section connects the grounding end; the connecting section extends perpendicularly from the first section; the second section extends perpendicularly from the connecting section; the first and second section are located on the same side of the connecting section; the feeding end connects the second section.

3. The antenna module as claimed in claim **1**, wherein the radiation member comprises a main radiation section and a contacting section connecting an end of the main radiation section; when the sliding board slides, the contacting section contacts or separates from the connecting member.

4. The antenna module as claimed in claim **3**, wherein the main radiation section includes a first portion, a second portion, and a third portion; the first and third portion perpendicularly extend from two ends of the second portion, respectively, and are located on the same side of the second portion; length of the third portion is greater than length of the first portion; the contacting section perpendicularly extends from an end of the third portion away from the second portion and is substantially parallel to the second portion.

5. The antenna module as claimed in claim **1**, wherein the connecting member is a flexible sheet.

6. The antenna module as claimed in claim **1**, wherein the antenna is electronically connected to a circuit board, the circuit board defines a notch at an edge portion; and the antenna is a planar sheet parallel to the circuit board and is positioned in the notch.

7. The antenna module as claimed in claim **1**, wherein the sliding board is slidably attached to a cover board, the cover board comprises an inner surface facing the antenna and an outer surface opposite to the inner surface; the outer surface defines a recess which includes a bottom wall; the bottom wall defines an opening through the inner surface; the sliding board is slidably received in the recess, with the radiation member exposed from the opening.

8. A wireless communication device, comprising:
a circuit board;
a cover board positioned opposite to the circuit board; and
an antenna module, the antenna module comprising:
an antenna electronically connected to the circuit board;
a connecting member attached to the antenna;
a sliding board slidably attached to the cover board to slide relative to connecting member; and
a radiation member attached to the sliding board;
wherein when the sliding board slides relative to the connecting member, the radiation member is in contact with or separates from the connecting member; and
wherein the circuit board defines a notch at an edge portion; and the antenna is a planar sheet parallel to the circuit board and is positioned in the notch.

9. The wireless communication device as claimed in claim **8**, wherein the antenna comprises a feeding end and a grounding end; and the feeding end and the grounding end both are electronically connected to the circuit board.

10. The wireless communication device as claimed in claim **9**, wherein the antenna further comprises radiation portion; the radiation portion has a first section, a connecting section, and a second section; the first section connects the grounding end; the connecting section extends perpendicularly from the first section; the second section extends perpendicularly from the connecting section; the first and second

section are located on the same side of the connecting section; the feeding end connects the second section.

11. The wireless communication device as claimed in claim **8**, wherein the cover board comprises an inner surface facing the antenna and an outer surface opposite to the inner surface; the outer surface defines a recess which includes a bottom wall; the bottom wall defines an opening through the inner surface; the sliding board is slidably received in the recess, with the radiation member exposed from the opening.

12. The wireless communication device as claimed in claim **8**, wherein the radiation member comprises a main radiation section and a contacting section connecting an end of the main radiation section; when the sliding board slides, the contacting section contacts or separates from the connecting member.

13. The wireless communication device as claimed in claim **12**, wherein the main radiation section includes a first portion, a second portion, and a third portion; the first and third portion perpendicularly extend from two ends of the second portion, respectively, and are located on the same side of the second portion; length of the third portion is greater than length of the first portion; the contacting section perpendicularly extends from an end of the third portion away from the second portion and is substantially parallel to the second portion.

14. The wireless communication device as claimed in claim **8**, wherein when the radiation member contacts the connecting member, a first current path is formed among the antenna, the connecting member, and the radiation member; when the radiation member separates from the connecting member, a second current path is formed between the antenna and the connecting member.

15. The wireless communication device as claimed in claim **8**, wherein the connecting member is a flexible sheet.

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